

tion such as the first stepping motor 406-1 and thus it can be accurately driven by a non-normal pulse which was determined as a suitable one.

Accordingly, a solar battery driven watch having a high speed rotational function such as a chronographical function can be provided.

More over, as in the second stepping motor 406-3, when a non-normal pulse is determined by a normal pulse used in the same stepping motor, not only a voltage condition but also a load condition are taken into account, and thus this conception can be applied to a stepping motor in which load can be varied.

Further, the present invention can provide a solar battery driven watch in which the hour/minute hand having a calendar load, can be accurately driven with high speed rotation or reverse rotation and also provided with an alarm function.

In these embodiments as mentioned above, although, the explanation has been made to an electronic watch having hands working by re-chargeable battery which can show a remarkable effect thereof, it is apparent that the present invention can be applied to an electronic watch having hands working by normal mercury battery or lithium battery as a power source and the same effect as explained in the above-mentioned embodiments can be obtained.

What is claimed is:

1. An electronic watch comprising:

a power supply;

an oscillator circuit;

means for generating a drive pulse;

a drive motor which drives a hand, in response to a drive pulse output from said drive pulse generating means;

drive circuit means for controlling drive of said motor;

means for controlling said drive circuit means; and

means, connected to said drive circuit control means, for detecting a control condition in said drive circuit control means,

said control condition detection means being provided with,

a first non-proper condition detecting means for detecting a non-proper condition of said drive motor, which senses an occurrence of a condition in which proper drive of said drive motor is not possible under a prescribed condition,

a first instructing means for instructing a change of a control mode which instructs said drive circuit control means to change the control mode that is currently being executed, in response to said detection signal output from said first non-proper condition detecting means,

a second non-proper condition detecting means for detecting a non-proper condition of said drive motor, which senses an occurrence of a condition in which proper drive of said drive motor is not possible under a prescribed condition even after the control mode has been changed for a predetermined period, and

a second instructing means for instructing a change of a control mode which instructs said drive circuit control means to change the currently executed control mode instructed by said second non-proper condition detecting means, to the original control mode when a non-proper condition of said drive motor has been detected within said predetermined period, which instructs said drive circuit control means to change the currently executed control mode instructed by said second non-

proper condition detecting means, to further separate control mode when non-proper condition of said drive motor has been detected within said predetermined period.

5 2. An electronic watch according to claim 1, wherein said drive pulse generation means comprises a group of drive pulse generation circuits which generate a plurality of types of drive pulses, said group including a normal hand-drive pulse generation circuit which generates a drive pulse for
10 normal hand drive based on a prescribed frequency generated from said oscillator circuit.

3. An electronic watch according to claim 1, wherein aid control mode change instructing means, in response to a detection signal of said non-proper condition detection
15 means, outputs an instruction to said drive circuit control means so as to stop the control mode which is currently being executed.

4. An electronic watch according to claim 1, wherein said control mode change instructing means, in response to a
20 detection signal of said non-proper condition detection means, outputs an instruction to said drive circuit control means so as to change control mode which is currently being executed to another control mode.

5. An electronic watch according to claim 1, wherein said
25 control mode change instructing means, in response to a detection signal of said non-proper condition detection means, outputs an instruction to said drive circuit control means so as to replace a drive pulse used in the control mode currently being executed to a another drive pulse.

30 6. An electronic watch comprising:
a power supply;
an oscillator circuit;
means for generating a drive pulse;
35 a drive motor which drives a hand, in response to a drive pulse output from said drive pulse generating means;
drive circuit means for controlling drive of said motor;
means for controlling said drive circuit means; and
means, connected to said drive circuit control means, for
40 detecting a control condition in said drive circuit control means,

said drive pulse generation means including at least a normal hand-drive pulse generating circuit, a fast-forward (high-speed) pulse generation circuit which
45 generates a fast-forward pulse in response to an operation of an external operating element, a reverse-rotation pulse generating circuit which generates a reverse-rotation pulse in response to an operation of an external operating element, and

50 said control condition detection means being provided with means for detecting a non-proper condition, and with a control mode change instructing circuit which, in response to an output signal of said non-proper condition detection means, causes a drive output signal
55 output from each one of said pulse generation circuits to selectively pass,

wherein in response to a discrimination signal output from said non-proper condition detection circuit, said mode
60 change instructing circuit prohibits said drive circuit control means from passing a reverse-rotation pulse.

7. An electronic watch according to claim 6, wherein said non-proper condition detection means comprising a voltage level discrimination circuit that detects the voltage level of
65 said power supply, and said drive pulse generation means is provided with a low-voltage fast-forward pulse generating means that generates a low-voltage fast-forward pulse which

has a width that is greater than said fast-forward pulse, and wherein when said power supply voltage is outside of a prescribed voltage range, in response to a discrimination signal output from said non-proper condition detection circuit, said mode change instructing circuit permits said drive circuit control means to pass a reverse-rotation pulse.

8. An electronic watch comprising:

a power supply;

an oscillator circuit;

means for generating a drive pulse;

a drive motor which drives a hand in response to a drive pulse output from said drive pulse generating means;

drive circuit means for controlling drive of said motor;

means for controlling said drive circuit means; and

means, connected to said drive circuit control means, for detecting a control condition in said drive circuit control means,

said drive pulse generating means including at least a normal hand-drive pulse generating circuit, a compensation drive pulse generation circuit, and a fast-forward (high-speed) pulse generation circuit,

said drive motor and said motor drive circuit means comprising a first drive motor which is driven by said normal hand-drive pulse, a first driving circuit means, a second drive motor driven by high speed pulse having higher driving speed than said normal hand drive pulse and a second driving circuit means,

said drive circuit control means including a load compensation control system which detects whether or not said first drive motor rotated in response to a prescribed drive pulse which is supplied by said first drive circuit means and in the case in which a judgement is made than the first drive motor did not rotate, which supplies a prescribed compensation drive pulse to said first drive circuit means, thereby compensating the rotation of the first drive motor, and

said control condition circuit means being provided with a non-proper condition detection means comprising a monitor circuit which monitors a rotating condition of the second drive motor, and being further provided with a control mode change instructing means which, in response to a detection signal which indicates the rotation condition of said second drive motor, stops execution of the load compensation system for said first drive motor.

9. An electronic watch according to claim 8, wherein in the case in which said control mode change instructing means stops the execution of the load compensation system with respect to said first drive motor by means of a detection signal from said non-proper condition detection means, said compensation drive pulse is supplied to said first drive motor.

10. An electronic watch comprising:

a power supply;

an oscillator circuit;

means for generating a drive pulse;

a drive motor which drives a hand, in response to a drive pulse output from said drive pulse generating means;

drive circuit means for controlling drive of said motor;

means for controlling said drive circuit means; and

means, connected to said drive circuit control means, for detecting a control condition in said drive circuit control means,

said drive pulse generating means including at least a normal hand-drive pulse generation circuit which gen-

erates a normal hand-drive pulse and a non-normal drive pulse generation circuit which generates a non-normal hand-drive pulse that differs from the normal hand-drive pulse, and also comprising a first drive motor which is driven by said normal hand-drive pulse, a first drive circuit means, a second drive motor which is driven by said non-normal hand-drive pulse and a second drive circuit means, and configured so that, from said normal hand-drive pulse generation circuit and non-normal hand-drive pulse generation circuit, a plurality of normal hand-drive pulses and compensation pulse having mutually differing drive capacities, and a plurality of non-normal hand-drive pulses and compensation pulses having mutually differing drive capacities are individually output,

said drive circuit control means including a load compensation control system which detects whether or not said first drive motor rotated in response to a prescribed drive pulse which is supplied by said first drive circuit means and in the case in which a judgement is made that the first drive motor did not rotate, which supplies a prescribed compensation drive pulse to said first drive circuit means, thereby compensating the rotation of the first drive motor,

and said control condition detection means being provided with,

a non-proper condition detection means which outputs predicted voltage information from said power supply voltage in said load compensation control system, and with

a control mode change instructing means comprising a selection circuit which, based on the information of said non-proper condition detection means, selects at least one drive pulse from at least one drive pulse group of the normal hand-drive pulse group and non-normal hand-drive pulse group which are output from said normal hand-drive pulse generation circuit and said non-normal hand-drive pulse generation circuit.

11. An electronic watch according to claim 10, wherein said drive circuit control means includes a load compensation control system in which after when the rotation of said first motor has been detected by changing a drive pulse for said first motor was changed, a second pulse is changed.

12. An electronic watch according to claim 10, wherein said first drive motor and said second drive motor are one and the same drive motor.

13. An electronic watch according to claim 10, wherein said non-normal hand-drive pulse generation circuit is a high-speed pulse generation circuit.

14. An electronic watch according to claim 10, wherein said non-normal hand-drive pulse generation circuit is a reverse-rotation pulse generation circuit.

15. An electronic watch comprising:

a power supply;

an oscillator circuit;

means for generating a drive pulse, comprising a group of drive pulse generation circuits which generate a plurality of types of drive pulses, said group including a normal hand-drive pulse generation circuit which generates a drive pulse for normal hand drive based on a prescribed frequency generated from said oscillator circuit, and at least one drive pulse generation circuit selected from the group comprising a compensation drive pulse generation circuit, a pulse generation circuit for a rotation detection signal of said drive motor, a low-voltage hand-drive pulse generation circuit, a fast-

forward (high-speed) pulse generation circuit, a low-voltage fast-forward pulse generation circuit, a reverse-rotation pulse generation circuit, and a functional hand drive high-speed rotation pulse generation circuit;

5 a drive motor which drives at least one of an hour/minute hand, a second hand, or a functional hand, in response to a drive pulse output from said drive pulse generating means;

10 drive circuit means for controlling drive of said motor; means for controlling said drive circuit means; and means, connected to said drive circuit control means, for detecting a control condition in said drive circuit control means,

15 said control condition detection means being provided with,

means for detecting a non-proper condition which sense an occurrence of a condition in which proper drive of said drive motor is not possible under a prescribed condition, and

20 means for instructing a change of a control mode which instructs said drive circuit control means to change the control mode that is currently being executed, in response to said detection signal output from said non-proper condition detecting means.

25 16. An electronic watch according to claim 15, wherein one pulse generation circuit which is selected from at least a normal hand-drive pulse generation circuit, a fast-forward (high-speed) pulse generation circuit, a reverse-rotation pulse generation circuit, and a functional hand drive high-speed rotation pulse generation circuit which are included in said drive pulse generation means further comprises individual pulse generation circuits which generate a plurality of types of drive pulses having mutually differing drive capacities.

35 17. An electronic watch according to claim 15, wherein said compensation drive pulse generation means includes one pulse generation circuit selected from said normal hand-drive pulse generation circuit, said fast-forward (high-speed) pulse generation circuit, said reverse-rotation pulse generation circuit, and said functional hand drive high-speed rotation pulse generation circuit.

18. An electronic watch comprising:

45 a power supply; an oscillator circuit; means for generating a drive pulse; a drive motor which drives at least one of an hour/minute hand, a second hand, or a functional hand, in response to a drive pulse output from said drive pulse generating means;

50 drive circuit means for controlling drive of said motor; means for controlling said drive circuit means, including a load compensation control system which detects whether or not said drive motor rotated in response to a prescribed drive pulse supplied by said drive circuit means, and if a judgement is made that said drive motor did not rotate, supplies a prescribed compensation drive pulse to said drive circuit means, thereby compensating the rotation of said drive motor; and

60 means, connected to said drive circuit control means, for detecting a control condition in said drive circuit control means,

said control condition detection means being provided with.

65 means for detecting a non-proper condition which sense an occurrence of a condition in which proper drive of

response to said detection signal output from said non-proper condition detecting means.

21. An electronic watch comprising:

- a power supply;
- an oscillator circuit;
- means for generating a drive pulse;
- a drive motor which drives at least one of an hour/minute hand, a second hand, or a functional hand, in response to a drive pulse output from said drive pulse generating means;
- drive circuit means for controlling drive of said motor;
- means for controlling said drive circuit means; and
- means, connected to said drive circuit control means, for detecting a control condition in said drive circuit control means,
- said control condition detection means being provided with,
- means for detecting a non-proper condition which sense an occurrence of a condition in which proper drive of said drive motor is not possible under a prescribed condition, including means for detecting a predicted voltage level of said power supply which is recognized by a load compensation control system, and
- means for instructing a change of a control mode which instructs said drive circuit control means to change the control mode that is currently being executed, in response to said detection signal output from said non-proper condition detecting means.

22. An electronic watch comprising:

- a power supply, wherein an output voltage of said power supply changes with the passage of time;
- an oscillator circuit;
- means for generating a drive pulse;
- a drive motor which drives at least one of an hour/minute hand, a second hand, or a functional hand, in response to a drive pulse output from said drive pulse generating means;
- drive circuit means for controlling drive of said motor;
- means for controlling said drive circuit means; and
- means, connected to said drive circuit control means, for detecting a control condition in said drive circuit control means,
- said control condition detection means being provided with,
- means for detecting a non-proper condition which sense an occurrence of a condition in which proper drive of said drive motor is not possible under a prescribed condition, and
- means for instructing a change of a control mode which instructs said drive circuit control means to change the control mode that is currently being executed, in response to said detection signal output from said non-proper condition detecting means.

23. An electronic watch according to claim 22, wherein said power supply comprises one type selected from a secondary battery, and a large capacitance condenser.

24. An electric watch comprising:
a power supply;
an oscillator circuit;
a means for generating a drive pulse;
a drive motor which drives a hand, in response to a drive pulse output
from said drive pulse generating means;
a drive circuit for controlling drive of said drive motor; and
a drive circuit controlling means for controlling said drive circuit; and said
electronic watch further comprising:
a means for detecting a non-proper condition which sense an occurrence
of a condition in which proper drive of said drive motor is not possible under a prescribed
condition; and
means for instructing a change of a control mode which instructs said
drive circuit controlling means to change the control mode that is currently being executed, in
response to said detection signal output from said non-proper condition detecting means,
wherein said means for instructing a change of a control mode instructs said drive circuit
controlling means for controlling said drive circuit means to return to the original controlling
mode which had been used before the current controlling mode was instituted, after said
control mode had been changed and no such detection signal has been output from said non-
proper condition detecting means.

25. An electronic watch according to claim 24, wherein said non-proper
condition detecting means is a means for detecting electric power which outputs a detecting
signal in response to a detection of reduction in power condition in said power supply.

26. An electronic watch according to claim 25, wherein said drive pulse
generation means is provided with a fast-forward (high-speed) pulse generation circuit which
generates a fast-forward pulse and a low-voltage fast-forward pulse generating means that
generates a low-voltage fast-forward pulse which has a pulse width that is greater than that of
said fast-forward pulse, and wherein said drive circuit controlling means permits passage of
said low-voltage fast-forward pulse, in response to said detection signal output from said
electric power detecting means.

27. An electronic watch according to claim 24, wherein said drive motor comprises a first drive motor and a second drive motor and wherein said non-proper condition detecting means is a means for monitoring a rotating condition of the second drive motor, while said control mode change instructing means is a means for instructing said drive circuit controlling means to change the control mode of said first drive motor, in response to said detection signal output from said non-proper condition detecting means.

28. An electronic watch according to claim 24, wherein said electronic watch further comprises a load compensation control system which detects whether or not said drive motor had been rotated in response to a prescribed drive pulse which is supplied by said drive circuit means and in the case in which a judgment is made that said drive motor had not been rotated, which supplies a prescribed compensation drive pulse to said drive circuit means, thereby compensating for the rotation of said drive motor, and further wherein said non-proper condition detecting means is a means for detecting an estimation electric power level of said power supply which is discriminated by said load compensation control system.

29. An electronic watch comprising:

a power supply;

an oscillator circuit;

a means for generating a drive pulse;

a drive motor which drives a hand, in response to a drive pulse output from said drive pulse generating means;

a drive circuit for controlling drive of said drive motor; and

a drive circuit controlling means for controlling said drive circuit; and said drive pulse generating means further comprising;

a normal hand-drive pulse generation circuit which generates a normal hand-drive pulse and a non-normal hand-drive pulse generation circuit which generates a non-normal hand-drive pulse that differs from the normal hand-drive pulse, and said electronic watch further comprising;

a means for detecting a non-proper condition which sense an occurrence of a condition in which proper drive of said drive motor is not possible under a prescribed condition; and

means for instructing a change of a control mode which instructs said drive circuit controlling means to prohibit an output of said non-normal hand-drive pulse, in response to said detection signal output from said non-proper condition detecting means.

30. An electronic watch according to claim 29, wherein said non-normal hand-drive pulse is a fast-forward pulse.

31. An electronic watch according to claim 29, wherein said non-normal hand-drive pulse is a reverse rotation pulse.

32. An electronic watch according to claim 29, wherein said drive motor comprises a first drive motor and a second drive motor and wherein said non-proper condition detecting means is a means for monitoring a rotating condition of the second drive motor, while said drive circuit controlling means for controlling said drive circuit prohibits said first driving motor from being driven by said non-normal hand-drive pulse.

33. An electric watch comprising:

a power supply;

an oscillator circuit;

a means for generating a drive pulse;

a drive motor which drives a hand, in response to a drive pulse output from said drive pulse generating means;

a drive circuit for controlling drive of said drive motor;

a drive circuit controlling means for controlling said drive circuit;

a means for detecting a non-proper condition which senses an occurrence of a condition in which proper drive of said drive motor is not possible under a prescribed condition; and

a load compensation control system which detects whether or not said drive motor had been rotated in response to a prescribed drive pulse which is supplied by said drive circuit, and in the case in which a judgment is made that said drive motor had not been rotated, supplies a prescribed compensation drive pulse to said drive circuit means;

a control mode change instructing means for instructing said drive circuit controlling means to stop said load compensation control system, in response to said detection

signal output from said non-proper condition detecting means.

34. An electronic watch according to claim 33, wherein said drive motor comprises a first drive motor and a second drive motor and wherein said non-proper condition detecting means is a means for monitoring a rotating condition of the second drive motor, while said drive circuit controlling means stops said load compensation control system of said first drive motor.

35. An electronic watch according to claim 33, wherein said non-proper condition detecting means is a means for detecting electric power which outputs a detecting signal in response to a detection of a reduction in power condition in said power supply.

36. An electronic watch according to claim 33, wherein said drive circuit controlling means supplies said compensation drive pulse to said drive circuit when said load compensation control system is stopped.

37. An electronic watch according to claim 24, wherein said drive pulse generating means comprises a normal hand-drive pulse generation circuit means which generates a normal hand-drive pulse and further comprising at least one means selected from a group of a low-voltage hand-drive pulse generating means, a fast-forward (high-speed) pulse generation circuit means, a low-voltage fast-forward pulse generating means, a reverse-rotation pulse generation circuit means, and a functional hand drive high-speed pulse generation circuit means.

38. An electronic watch according to claim 37, wherein at least one of said means selected from a group of said normal hand-drive pulse generation circuit means, said fast-forward (high-speed) pulse generation circuit means, said reverse-rotation pulse generation circuit means, and said functional hand drive high-speed pulse generation circuit means, each of which being included in said drive pulse generating means generates a plurality of types of drive pulses having mutually different drive capacities from each other.

39. An electronic watch according to claim 38, wherein said electronic watch further comprises a load compensation control system which detects whether or not said drive motor had been rotated in response to a prescribed drive pulse which is supplied by said drive

circuit means, and in the case in which a judgment is made that said drive motor had not been rotated, supplies a prescribed compensation drive pulse to said drive circuit means, thereby compensating for the rotation of said drive motor, and further wherein said compensation drive pulse includes at least one means selected from a group of said normal hand-drive pulse generation circuit means, said fast-forward (high-speed) pulse generation circuit means, said reverse-rotation pulse generation circuit means, and said functional hand drive high-speed pulse generation circuit means.

40. An electronic watch according to any one of claims 24, 29 and 33, wherein said control mode change instructing means, in response to a detection signal of said non-proper condition detection means, outputs an instruction to said drive circuit controlling means so as to stop the control mode which is currently being executed.

41. An electronic watch according to any one of claims 24, 29 and 33, wherein said control mode change instructing means, in response to a detection signal of said non-proper condition detection means, outputs an instruction to said drive circuit controlling means so as to change a control mode which is currently being executed to another control mode.

42. An electronic watch according to any one of claims 24, 29 and 33, wherein said control mode change instructing means, in response to a detection signal of said non-proper condition detection means, outputs an instruction to said drive circuit controlling means so as to replace a drive pulse used in the control mode currently being executed to another drive pulse.

43. An electronic watch according to any one of claims 24, 29 and 33, wherein said electric power of said power supply is varied with the passage of time.

44. An electronic watch according to any one of claims 24, 29 and 33, wherein said power supply comprises one type selected from a titanium-lithium battery, a large capacitance condenser, a secondary battery and a solar battery.

45. An electronic watch according to claim 24, wherein said non-proper condition detecting means further comprising a first non-proper condition detecting means for

detecting a non-proper condition of said drive motor, which sense an occurrence of a condition in which proper drive of said drive motor is not possible under a prescribed condition, and a second non-proper condition detecting means for detecting a non-proper condition of said drive motor which senses an occurrence of a condition in which proper drive of said drive motor is not possible under a prescribed condition even after the control mode had been changed for a predetermined period; and

said control mode change instructing means further comprising a first instructing means for instructing a change of a control mode which instructs said drive circuit control means to change the control mode that is currently being executed, in response to said detection signal output from said first non-proper condition detecting mean, and a second instructing means for instructing a change of a control mode which instructs said drive circuit control means to change the currently executed control mode instructed by said second non-proper condition detecting means to the original control mode when a non-proper condition of said drive motor has not been detected within said predetermined period, and which instructs said drive circuit control means to change the currently executed control mode instructed by said second non-proper condition detecting means, to a further separate control mode when non-proper condition of said drive motor has been detected within said predetermined period.